"REVIEW ON NUTRITIONAL, MEDICINAL VALUE OF CAMEL MILK AND ITS PUBLIC HEALTH IMPORTANCE"

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ABSTRACT

Of 25.89 million camels in the world, 80% are found in Africa and 20% million in Asia. The camels produce more milk and for longer period of time than any other milk animal held under the same harsh conditions. It is a multi-purpose animal with huge productive potential and has been utilized by humans for transport, milk, meat and skin. Camel milk is one of the main components of the pastoral community's basic diet, which contributes up to 30% of the annual caloric intake. The main component of milk which has a major impact on its nutritional value and technological suitability is protein. Milk proteins are a heterogeneous group of compounds that differ in composition and properties. Camel milk is a good substitute for human milk as it does not contain β -lacto globulin. Many research findings proved that Camel milk is easily digested by lactose-intolerant individuals. It is rich in healthy vitamins and minerals, especially vitamins B, vitamin C and iron. The lactoferrin in camel milk has also medicinal values: antibacterial, antiviral and anti-tumor properties. It contains disease-fighting immunoglobulin's which are small in size, allowing penetration of antigens and boosting the effectiveness of the immune system. It is a rich source of insulin and also it containing approximately 52 units of insulin in each liter of camel milk, making it a great treatment option for Type 1 or Type 2 diabetics as well as Gestational Diabetes. Even if camel milk has the above importance, consuming it with poor hygiene along the camel milk value chain has impact on public health. Our country having this resource should formulate policies and strategies regarding camel milk production, research and extension.

Keywords: Camel Milk, Medicinal value, Nutritional Value, Public health importance

1. INTRODUCTION

1.1. Back Ground and Justification

There are 25.89 million camels in the world with 80% of them in the four north east African countries Somalia, Sudan, Kenya and Ethiopia. From the total population of camel in the world 89% are one humped dromedary camels (Camelusdromedarius) and the remaining 11% are the two-humped (Camelusbactrianus) that generally found in the cold deserts of Asia. Ethiopia takes the 3rd place in Africa next to Somalia (with over 6 million heads is first) and Sudan in possessing 2.4-million dromedary camels (Farah and Fischer, 2004; FAO, 2011; FAO, 2013). Ethiopia camels are kept in arid and semi-arid lowlands such as Borana, Somalia and Afar regions (Roger, 2006; Teshome *et al.*, 2003; Simeneh *et al.*, 2015). They serve as an important source of milk, meat, draught power and transportation for the pastoralists (Abdelhakim and Youcef, 2012; Bekele,

1999). In recent years, camels have become one of the national export animals for Ethiopians.

This camel (*Camelusdromedarius*) is of significant socio-economic importance in many arid and semi-arid parts of the world and its milk constitutes an important component of human diets in these regions (Schwartz and Dioli, 1992; Farah, 1986). Camel milk is still the most important nutritional source for pastoralists in many Asian and African countries (ValérieEberlein,2007). Dromedary camels produce more milk of high nutritional quality and for a longer period of time than other species in an environment that may be rightly termed as hostile in terms of extreme temperature, drought and lack of pasture (Yagil and Etzion, 1980; Hattem *et al.*, 2011). The daily yield of camel milk ranges from 3 to 10 kg in a lactation period of 12 to 18 months (Gizachew *et al.*, 2014). Ethiopia which possesses about 2.4 million heads camels ranks second in camel milk production in the world next to Somalia. The annual camel milk production in Ethiopia is estimated as 75,000 tones (Asres and Yusuf, 2014). Camels can graze on low productive pastures on which the production of milk is possible and economically profitable. For this reason, camels may reduce the dependence of pastoralists on other livestock that usually is much more vulnerable to drought than camels-(Farah, 1993; Farah, 2004).

There are few countries as the UAE, Saudi Arabia, Mauritania and Kazakhstan where camel dairies exist and camel milk and milk products are produced in pasteurized form for placing on the national market (ValérieEberlein, 2007). Average milk yield of camel per day ranged between 3.5 (under desert conditions) to 40liters (under intensive management). This great variation in camel milk production may be attributed to the high genetic variation between individuals, breed, feeding and management conditions, type of work, milking frequency, age of animal, persistency of lactation, lactation number and stage of lactation (Khaskheli, *et al.*, 2005; Sawaya *et al.*, 1984; FAO, 1982; Khan, and Iqbal, 2001). Depending on management and environmental conditions, the average lactation length in camel is 12 months with a range from 9 to 18 months (Khaskheli, *et al.*, 2005; Ahmed *et al.*, 2015; Knoess., 1979). it is much more nutritious than that from cow milk because it is low in fat and lactose contents, and higher in potassium, iron and vitamin C (Sawaya, W. *et al.*, 1984, Abu–Lehia, I. 1990, Abu–Tarboush, H. 1996) other than the above value camel milk has medicinal properties and is used in some parts of the world to cure certain diseases (bacterial, viral, tumor and others) (Attia *et al.*, 2001). There is reports that camel milk has medicinal properties (Gader *et al.*, 2016; Yagil, 1982) suggesting that this milk contains protective proteins which may have possible role for enhancing immune defense mechanism.

Camel milk also contains higher amount of zinc. The rapidly dividing cells of the immune system are sensitive to zinc deficiency. The role of Zn in the development and maintenance of a normally functioning immune system has been well established (Hansen *et al.*, 1982). Antibacterial and antiviral activities of these proteins of camel milk were studied (El-Agamy *et al.*, 1992). Camel milk has insulin like activity, regulatory and immunomodulatory functions on β cells. Camel milk exhibits hypoglycemic effect when given as an adjunctive therapy, which might be due to presence of insulin/insulin like protein in it and possesses beneficial effect in the treatment of diabetic patients. Camel milk has been used for the treatment of food allergies, crohns disease and autism (Shabo and Yagil, 2005).

The value of camel milk in human nutrition and medicine has so far received very little factual and academic attention especially in our country Ethiopia which is rich in the camel. Accordingly, the present review will be reviewed to determine the nutritional, medicinal value of camel milk and its public health importance on the basis of the available literature. Even if a numerous review has been carried out in different milking animals in the world, the importance and use of camel milk and its products was not reviewed which created paucity of information in the area.

1.2. Objectives

A numerous reviews have been carried out in different milking animals despite these all benefits, medicinal values of camel milk and its public health importance were not reviewed well which created information gap in the area.

Therefore in the line with the above, the objectives of this paper are

- To review available information on benefits, chemical composition and medicinal values of camel milk
- > To review public health importance of camel milk along the value chain.
- > To recommend further investigation concerning benefits, nutritional and medicinal values of camel milk based on the information from this review

2. LITRATURE REVIEW

2.1. Properties and Chemical Composition of Camel Milk

Camel milk is generally opaque, white in color, faint sweetish odor and different in taste. Sweet, sharp and salty nature of taste is due to the type of plants eaten in the desert by the camels and availability of drinking water (Abbas, 2013; Khaskheli *et al*, 2005). Camel milk contains little fat, in average about 2%; and this fat consists of mainly polyunsaturated fatty acids that are completely homogenized and gives the milk its smooth white appearance where as the changes in taste are caused by the type of fodder and availability of drinking water (Yadav *et al.*, 2015; Kamal and Abdalla, 2012). It is frothy when shaken slightly and less viscous than bovine milk with average specific gravity of 1.029 (Patel *et al.*, 2016). In fresh camel milk the density ranges from 1.026-1.035 and the pH from 6.2-6.5, both are lower than those of the cow's milk and maximum buffering capacity of skim milk is at pH 4.95 (Gul *et al.*, 2015) . This pH of the milk allows enhanced absorption of milk constituents from the duodenum, especially the iron. The low pH of camel milk is due to higher concentration of vitamin C, this acidity stabilizes the milk and therefore it can be kept for relatively longer periods without cream layer formation (Khaskheli *et al.*, 2005).

The most important property of camel milk is that it can be kept for longer periods than cattle milk when refrigerated and even with the desert heat it does not spoil very soon, and it remains quite stable at room temperature and takes a comparatively longer time to become sour (Dukwal *et al.*, 2007). Camel milk is a rich source of protein with potential antimicrobial and protective activities. These proteins are not found in cattle milk or found only in minor amounts. The most important one is alphalactoalbumin, which is similar to the enzyme Lysozme, which inhibits the growth of bacteria (Wernery, 2003). Camel milk is not affected by acidic environment and does not form coagulum in acidic environment such of the stomach. Camel milk has high percentage of water content, which ranges from 86-91% and it is inversely proportioned to the availability of drinking water to camels. This makes camel milk a valuable source of water for suckling young camels and the camel herdsmen who are normally live in scarce water areas (Abdalla, 2014). Camel milk has poor coagulation properties, because fat globules are army bound to the proteins. In addition to that fat is distributed as small micelle-like globules in the milk (Eyassu, 2007).

According to most authors, the composition of camel milk varies due to difference of geographical origin and year of publication of the published datas but other factors such as the physiological stage, feeding conditions, seasonal or physiological variations, genetic or health status of camel have also a paramount importance (Konuspayeva *et al.*, 2009). In general the average amount of components of camel milk is protein 3.4%; fat 3.5%; lactose 4.4%; ash 0.79%, while water covers 87% (Kanhal and Hamad, 2010). (Table 1)

Table 1: List of different species milk chemical composition Source

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Species	Water %	Protein %	Fat %	Ash %	Lactose %
Camel	86-88	3.0-3.9	2.9-5.4	0.6-0.9	3.3
Cow	85-87	3.2-3.8	3.7-4.4	0.7-0.8	4.8-4.9
Buffalo	82-84	3.3-3.6	7.0-11.5	0.8-0.9	4.5-5.0
Sheep	79-82	5.6-6.7	6.9-8.6	0.9-0.1	4.3-4.8
Goat	87-88	2.9-3.7	4.0-4.5	0.8-0.9	3.6-4.2
Human	88-89	1.1-1.3	3.3-4.7	0.2-0.3	6.8-7.0

Source: (Kanhal and Hamad, 2010) 2.2. Nutritional Value of Camel Milk

2.2.1. Proteins

The main component of milk, which has a major impact on its nutritional value and technological suitability, is protein. Milk proteins are a heterogeneous group of compounds that differ in composition and properties (Gizachew *et al.*, 2014). Dromedary camel milk contains 3 to 3.90 percent of protein (table 1). It contains two main groups (Caseins and Whey proteins) and relatively higher amount immune proteins (Peptidoglycan Recognition Protein, Lactoferrin Lysozyme *and* Lactoperoxidase) and insulin (Guo and others, 2007; Abbas *et al.*, 2013; Gul *et al.*, 2015).

Casein is the most important and higher in proportion, while the proportion of whey proteins is relatively low (Guo *et al.*, 2007). Shamsia (2009) also confirmed that camel milk contains higher protein (especially casein) and lower in whey milk than human milk.

Dromedary camel milk has 1.63 to 2.76 percent of casein protein that constitutes 52 to 87 percent of total milk protein (Khaskheli et al., 2005), as from the above evidence Casein is a major part of protein in camel milk. There are 4 main casein fractions casein: $\alpha s I$ -, $\alpha s 2$ -, β -, and κ their proportion is diverse and polymorphism of these proteins was demonstrated in most of the animal species (Barłowska, 2007). The human casein does not contain the αs1-fraction, which is the predominant factor causing milk protein allergy. However; it is rich in the β -fraction. Conversely, casein in cow and buffalo milk is very abundant (38.4% and 30.2% of total casein, respectively) in the αs1-fraction (Zicarelli, 2004). Milk protein allergy (MPA) is an allergic reaction to proteins commonly found in cow milk. It is caused by the immune system reacting to the milk proteins as they would present a threat to the body. An activated immune system reacts just as it would to a foreign virus or a toxin. Several studies have demonstrated that the majority of children with cow milk protein allergy (CMPA) synthesize antibodies predominantly against α -casein and β-lacto globulin (Lara et al., 2005). Some infants and children allergic to cow milk will have an allergic reaction after ingesting buffalo, goat, sheep and horse milk proteins due to the presence of positive immunological cross-reaction with their counter parts in cow milk (El-Agamy et al., 2009). Camel milk is a good substitute for human milk as it does not contain β -lactoglobulin, a typical milk protein characteristic of ruminant milk. Another crucial anti-allergenic factor is that the functional components of camel milk include immunoglobulin similar to those in human milk, which are known to reduce children's allergic reactions and strengthen their future response to foods (Shabo et al., 2005). El-Hatmi et al., (2007) reported that camel milk contains higher amounts of antibacterial substances (for example, lysozyme, lactoferrin, and immunoglobulin) as compared to cow and buffalo milk. In whole casein portion, β-CN is 65 percent and αs1-CN is 21 percent. Camel milk has more digestibility and less allergic reactions in infants as α s-CN slowly hydrolyze than β -CN (El-Agamy *et al.*, 2009).

Whey protein is the second biggest fraction of protein of camel milk which covers 20 to 25 percent of camel milk protein. The milk of dromedary camel has a whey protein in range of 0.63 and 0.80 percent (Khaskheli *et al.*, 2005). B-lactoglobulin is found in trace, while α-lactalbumin comprises the major camel milk portion. In the milk of bovines, α-lactalbumin constitute only 25 percent, while β-lactoglobulin made 50 percent of the total whey protein that make it the major whey protein of bovine milk(Laleye *et al.*, 2008). Whey protein of camel milk consists of some other main components such as peptidoglycan, recognition protein, immunoglobulins, lactoferrin and serum albumin (Kappeler *et al.*, 2005) *Peptidoglycan Recognition Protein* (PGRP); its highest concentration was first discovered in camel milk and it has apparent effect on breast cancer by controlling metastasis and stimulates the hosts immune response (Gizachew *et al.*, 2014). It stimulates the hosts' immune response and has potent antimicrobial activity. It even appears to have an effect on breast cancer in studies (Gul *et al.*, 2015).

Lactoferrin is a glycoprotein which has an ability to bind two metal cations (preferably Fe 3+) to the binding sites that are structurally closely related. The majority of lactoferrin is needed for transportation or storage of iron and posses antioxidant properties. Lactoferrin contents of camel milk (0.22 mg/L-1) were significantly higher than goat, sheep, buffalo and cow milk (Abas *et al.*,2013). The research of El-Hatmi(2007) revealed that highest level of lactoferrin (2.3 g/L-1) was noticed after 2 days of parturition.

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Lactoferrin is among the protective proteins in camel milk with higher concentration and thus prevents microbial overgrowth and invading pathogens (Hosam *et al.*, 2013)

Lactoperoxidase *is* resistant to acidic and proteolytic digestion contributes to the non-immune host defense system, exerting bactericidal activity, growth promotion activity, anti-tumor activity and it has a close relation (71%) to human thyroid peroxidase, which is involved in iodination and coupling in the formation of the thyroid hormones(Mullaicharam *et al.*, 2014). Lactoperoxidase has bactericidal activity mainly on gram-negative bacteria like Escherichia *coli*, Salmonella, and, Pseudomonas, (Abbas *et al.*, 2013; Gul *et al.*, 2015).

Lysozyme is a protective protein highest in camel milk than milk of cow and human. It has antibacterial activity gram-positive bacteria like N-acetyl-beta-D-glucosamidase (NAGase) found in similar quantities in human milk (Gul *et al.*, 2015).

The immunoglobulins in camel milk contribute to camel milk's incredible infection fighting. Camel Igs are able to penetrate tissues and cells that human Igs were unable to. Because of their reduced size, one-tenth the size of human antibodies, thus can readily pass to the milk of the lactating camel, can pass the BBB, and readily absorbed from the gut into the general circulation (Gader, 2016). Additionally, the level of immunoglobulin G in camel milk is 1.64 mg.mL-1 which is highest as compared to 0.70, 0.67, 0.55, 0.63 and 0.86 mg.mL-1 for goat, cow, sheep, buffalo and human milk respectively (El-Agamy and Nawar, 2009).

2.2.2. Milk lipids

Fat is the major substance defining milks energetic value and makes a major contribution to the nutritional properties of milk, as well as to its technological suitability. Milk fat globules have an average diameter of less than 0.1 μ m to approximately18 μ m (El-Zeini, 2006) and consist of a triglyceride core surrounded by a natural biological membrane. The milk fat globules membrane (MFGM) contains the typical components of any biological membrane such as cholesterol, enzymes, glycoproteins, and glycolipids (Fauquant *et al.*, 2007). Mansson (2008) claims that lipids build 30% of the membrane and can be further broken down into the following groups: phospholipids (25%), cerebrosides (3%), and cholesterol (2%). The remaining 70% of the membrane consists of proteins. Fat globules with the biggest average diameter are found in buffalo milk (8.7 μ m), the smallest in camel (2.99 μ m) and goat milk (3.19 μ m). A high state of dispersion of milk fat has a positive influence on the access that lipolytic enzymes have to small fat globules (SFGs). Therefore, milk from goats or camels is more digestible for humans (Durso *et al.*, 2008). The lipid fraction in camel milk is characterized by a high proportion of long chain fatty acids, which accounts for 96.4 percent compared to 85.3 percent in bovine milk (Abbas, *et al.*, 2013).

Cholesterol is present in the milk fat globule membrane (MFGM) and it accounts for 95% of the sterols of milk fat. SFGs are characterized by a larger surface area of MFGM per fat unit. Therefore, a bigger share of SFGs is connected with a relatively higher concentration of cholesterol in milk. It is reported that the cholesterol level of fat of camel milk (34.5 mg.100 g-1) is higher as compared to cholesterol level (25.63 mg.100 g-1) of bovine milk fat (Konuspayeva *et al.*, 2008). Milk fat of dromedary camels carries a lower level of carotene and lesser concentrations of short chain fatty acids as compared to milk of bovine (Stahl *et al.*, 2006). Camel milk, which has the highest state of dispersion of milk fat, contains the most (of the studied animals species) cholesterol (31.3 to 37.1 mg/100 g milk).

Camel milk is also unique concerning its fatty acid profile. It contains 6 to 8 times less of the short chain fatty acids compared to milk from cows, goats, sheep, and buffalo (Gizachew *et al.*, 2014; Ceballos *et al.*, 2009), Various fatty acids such as butyric, caproic, caprylic, capric, lauric, myristic, myristoleic, palmitic, palmitoleic, stearic, oleic, linoleic and arachidic acids are present in camel milk (Panwar *et al.*, 2015). One of the specific features of camel milk is the presence of the fore mentioned CLA, which has numerous functional properties. The most biologically active is the Diane of configuration *cis-9*, *trans-*

11(octadecadienoic); it is claimed to inhibit the occurrence and development of cancer of the skin, breast, colon, and stomach, while its isomer *trans*-10; *cis*-12 is thought to prevent obesity (Wang and Jones, 2004).

Additionally, CLA reduces the levels of triglycerides, total cholesterol, including LDL; and thus improves the ratio of LDL/HDL in plasma, which is a crucial factor in the prevention of coronary heart disease and arteriosclerosis. CLA also is said to inhibit the development of osteoporosis, to improve the metabolism of lipids, to reduce the blood glucose level, and to stimulate the immune system (OShea *et al.*, 2004).

The level of dromedary camel milk fat believed to be 2.9 to 5.4 percent (table1) and can be reduced from 4.3 to 1.1 percent in the milk of thirsty camels (Haddadin *et al.*, 2008, Konuspayeva *et al.*, 2009). But, a recent study reported as camel milk contains only 2% fat which are mainly composed of polyunsaturated fatty acids and omega fats (Gul *et al.*, 2015).

2.2.3. Carbohydrate

The major carbohydrate fraction in camel milk is lactose sugar with range between 3.3 to 5.80 percent (table 1). The nature of vegetation eaten by the camels in desert areas could be a significant factor for extensive variation in lactose contents. Camels generally like to take halophilic plants like Salosa, Acacia and Artiplex to fulfill their physiological necessities of salts. However, in some dromedary varieties of the world lactose contents found to be changed slightly over a period of time (Abas *et al.*, 2013). Lactose readily digested by human lactase with no signs of "lactose intolerance".

2.4.4. Minerals

Milk is an important source of mineral substances, especially calcium, phosphorus, sodium, potassium, chloride, iodine, magnesium, and small amounts of iron. The main mineral compounds of milk are calcium and phosphorus, which are substantial for bone growth and the proper development of newborns. The high bio availability of these minerals influences the unique nutritional value of milk. Camel milk is the richest in these minerals (Al-Wabel, 2008; Onjoro et al., 2003). Average values of Na (29.70 mg/L-1), K (50.74mg/L-1), Ca (94.06 mg %), P (41.68 mg %) and Mg (11.82 mg %) present in milk of early lactating camels. In late lactation period, the corresponding levels were 35.49±0.89 mg/L-1, 71.86±1.43 mg/L-1, 97.32±0.51 mg%, 47.14±0.52 mg% and 13.58±0.31mg %, respectively (Mal et al., 2007). The differences in macro-minerals levels reported by various research groups might be due to breed differences or as a result of environmental conditions such as feed, water intake and soil (Haddadin et al., 2008). Different breeds of camels have different capacities to deposit minerals in their milk (Wangoh et al., 1998). The concentration of Fe, Zn and Cu were 1.00012, 2.00002, 0.44004 mg/dl, respectively. The values of trace minerals viz. Fe, Zn, and Cu were significantly higher in camel milk as compared to bovine milk (Singh et al., 2006). Generally the total amount mineral dromedary camel milk is between 0.60 to 1.0 percent (Konuspayeva et al., 2009). The mean values for zinc, manganese, magnesium, iron, sodium, potassium and calcium in mineral contents of dromedary camel milk (100g-1) are 0.53, 0.05, 10.5, 0.29, 59, 156 and 114 mg respectively (Abas *et al.*, 2013).

2.2.5. Vitamins and electrolytes

Milk is a valuable source of vitamins, both water-soluble and fat-soluble ones and especially dromedary camel milk is rich in vitamins like D, E, A, C and A (Haddadin *et al.*, 2008; Stahl *et al.*, 2006). Camel milk is a kind of exception because of its high concentration of vitamin C. Camel milk contains 30 times more vitamin C than cow milk does, and 6 times more than human milk. This is highly important in desert areas, where fruits and vegetables are scarce. Therefore, camel milk is often the only source of vitamin C

in the diet of inhabitants of those regions (Haddadin et al., 2008). It was reported that camel milk contains higher concentration of niacin (B3) as compared to bovine milk. According to USDA (2009), milk (250 mL) of dromedary camel nourish a normal adult by means of 10.5 percent of ascorbic acid (C), 5.25 percent of vitamin A, 8.25 percent of riboflavin (B2), 15.5 percent of cobalamin, pyridoxine and thiamin of the Recommended Daily Intake (RDI). In comparison, bovine milk (250mL) nourish a normal adult by means of 9 percent of vitamin A, 3.5 percent of ascorbic acid (C), 11.5 percent of pyridoxine (B6), 36 percent of riboflavin (B2). Generally the levels of vitamin A, E and B1 were reported to be low in camel milk compared to the cow milk. Cow milk contains 99.6±62.0 μg% β-carotene and it is not detected in camel milk. The concentration of vitamin C in camel milk in early and late lactation has been reported 5.26±0.47 and 4.84±0.20 mg%, respectively. The vitamin C content in camel milk is two to three folds higher in camel milk compared to cow milk. The levels of vitamin A, E and B1 were higher in camel colostrum than mature camel milk. However, the vitamin C content remains higher in mature camel milk. The higher vitamin C content maybe attributed to the more synthetic activity in the mammary tissues during early phase of lactation that declined as lactation advanced (Stahl et al., 2006). The low pH due to the vitamin C content stabilizes the milk and can be kept for relatively longer periods. The availability of a relatively higher amount of vitamin C in raw camel milk is of significant relevance from the nutritional point as vitamin C has a powerful anti-oxidant action. Camel milk can be an alternative source of vitamin C under harsh environmental conditions in the arid and semi arid areas (Mal et al., 2007).

vitamin C and important electrolytes like calcium and iron are need for duodenal acid for calcium absorption in cases of osteoporosis is satisfied by camel milk rapidly passing the stomach, with the acid that is constantly being secreted and the vitamin C (ascorbic acid) increasing the amount of calcium absorbed and deposited in the bones (Levy A *et al.*, 2013).

2.3. Medicinal Value of Camel Milk

Camel milk, used medicinally for centuries by nomadic people and in the last twenty years ago many studies have reported the use of camel milk in the treatment of human disease. In Kazakhstan, camel milk and fermented milk products (Shubat) can be used as medicament for stomach and intestinal diseases (Konuspayeva and Faye, 2011). This effect has been attributed of the presence of antimicrobial substances camel milk, including lysozymes, hydrogen peroxide, lactoferrin, lactoperoxidase, immunoglobulin's (Elagamy et al., 1992). Then the camel milk was much experienced about the healing properties and it has been used for the treatment of a number of health problems in humans (Sharmanov and Dzhangabylov, 1991; Agrawal et al., 2003; Shabo et al., 2005; Mal et al., 2006). Furthermore found Elagamy et al., (1992) that the lacto peroxidase camel milk acts as a bacteriostatic activity against Grampositive strains and as bactericides against Gram-negative cultures. Scientists believe that antibodies in camel milk could be effective against cancer, HIV/AIDS, Alzheimer's disease and hepatitis C (Martin et al., 1997; Agrawal et al., 2003; Magjeed, 2005; Shabo et al., 2005; Habib et al., 2013). Currently, there are still many busy figuring out whether camel milk can also be effective prophylactic against diabetes and heart disease (Zagorski et al., 1998; El-Sayed et al., 2011; Malik et al., 2012; Shori, 2015). Also in recent years, it was intensively researched of antibacterial lactoferrin in the camel milk (Al-Majali et al., 2007). In addition, probiotic lactic acid bacteria were isolated from camel milk (Yateem et al., 2008), which are important for the health of the people. These potential health benefits of camel milk are described individually in the following sections.

2.3.1. Anti-diabetic property

There is a traditional belief in the Middle East that regular consumption of camel milk helps in the prevention and control of diabetes. Recently, it has been reported that camel milk can have such properties. Literature review suggests the following possibilities: i) insulin in camel milk possesses special

properties that makes absorption into circulation easier than insulin from other sources or cause resistance to proteolysis; ii) camel insulin is encapsulated in nano particles (lipid vesicles) that make possible its passage through the stomach and entry into the circulation; iii) some other elements of camel milk make it anti-diabetic. Sequence of camel insulin and its predicted digestion pattern do not suggest differentiability to overcome the mucosal barriers before been degraded and reaching the blood stream. However, we cannot exclude the possibility that insulin in camel milk is present in nano particles capable of transporting this hormone into the blood stream. Although, much more probable is that camel milk contains 'insulinlike' small molecule substances that mimic insulin interaction with its receptor (Ajamaluddin et al., 2012). The long-term study was undertaken previously to assess the efficacy, safety and acceptability of camel milk as an adjunct to insulin therapy in type 1diabetics. In randomized clinical, parallel design study, type 1 diabetic patients were enrolled and divided into two groups. Group I received usual care that is, diet, exercise and insulin and Group II received camel milk in addition to the usual care. Insulin requirement was titrated weekly by blood glucose estimation. The results showed that, in camel milk group, there was decrease in mean blood glucose, hemoglobin's and insulin doses. Out of subjects receiving camel milk, insulin requirement reduced to zero. There was non-significant change in plasma insulin and anti-insulin antibodies in both the groups. It may be stated that camel milk is safe and efficacious in improving long-term glycemic control, with a significant reduction in the doses of insulin in type 1diabetic patients (Amjad et al., 2013). In India, a comparison between conventionally treated juvenile diabetes with those also drinking camel milk showed that the group drinking the milk had significantly reduced blood sugar and reduced Hb levels (Agrawel et al., 2002). The amounts of injected insulin were also significantly reduced. Insulin in milk is proved by the following many research outcomes: (a) Camel milk contains large concentrations of insulin 150U/ml. (b) Fasted and dehydrated rats and rabbits had a decline in blood sugar after receiving camel milk. As fasting nullifies insulin secretion; the drop in blood sugar indicates insulin activity. It must be noted that fasted rabbits used to be the bioassay for insulin – the concentration of insulin given as rabbit units. (c) Streptozotocin induced diabetes in rats was controlled and cured with camel milk. (d) Although human, cow and goat milk contain insulin, it is degraded in the acid environment of the stomach. This does not occur with camel milk which does not react to acid and no coagulum is formed. Personal observation in a calf which died 2 hours after suckling: no coagulum was present in stomach although it was filled with milk (Zagorski et al., 1998).

2.3.2. Anti-bacterial and immunological properties

Camel immune system: IgM, IgG, IgA and even IgD have been detected in camel sera on the basis of Cross-reactivity with human immunoglobulin's (Abulehiya, 1997).

Hamers-Casterman *et al.* (1993) described the amazing camel immune system, different from all other mammalians. Sub classes IgG2 and IgG3 (natural for camels) consist of only two heavy chains. Light chains (VL) are not present. There is a single V domain (VHH). Camel VHH have a long complementary determining region (CDR3) loop, compensating for absence of the VL Conventional antibodies rarely show a complete neutralizing activity against enzyme antigens (Hamers, 1998). Camel IgG has a full neutralizing activity against tetanus toxin as it enters the enzymes structure. Camel hyper variable regions have increased repertoire of antigen binding sites. Camel VHH domains are better suited to enzyme inhibitors than human antibody fragments, thus offering a potential for viral enzymatic neutralization (Reichmann and Muylderman, 1999). A major flaw in the development of human immune therapy is the size of the antibodies. The comparative simplicity, high affinity and specificity of camel Igs, and the potential to reach and interact with active sites allow for penetration of dense tissues reaching the antigen. Camels' immune system is stronger than that of humans. As immunoglobulins are found in camel milk throughout lactation, drinking milk will provide a tool for combating autoimmune diseases by rehabilitating the immune system rather than is depression (Muylderman *et al.*, 2001).

2.3.3. Anti-bacterial activity

Camel milk contains various protective proteins mainly enzymes which exert antibacterial and immunological properties. The presence of these proteins helps explain some of the natural healing properties of the milk (Farah, 1993). According to Conesa et al., 2008; Ueda et al., 1997 and Kiseley, 1998, the known protective proteins, and their immunological action, in camel milk are: Lysozymes; participates in primary immune system, which is based on targeting of structures common to invading pathogens. Immunoglobulins; These give the immune protection to the body against infections; Lactoferrin: Iron-saturated lactoferrin (from second week lactation) prevents microbial growth in gut, participates in primary immune system, which is based on targeting of structures common to invading pathogens. Camel milk apparently contains much more lactoferrin than in ruminant (cow, sheep and goat) milk; Lactoperoxidase: is found in milk, tears and saliva. It contributes to the non-immune host defense system, exerting bactericidal activity (mainly on gram negative bacteria), has growth promotion activity, has anti-tumor activity, has a close relation (71%) to human thyroid peroxidase, which is involved in iodination and coupling in the formation of the thyroid hormones; Peptidoglycan recognition protein(PGRP): the highest concentrations of this enzyme is in camel milk, was first discovered in camel milk, has apparent effect on breast cancer by controlling metastasis, stimulates the host's immune response. Broad antimicrobial activity N-acetyl-§-glucosaminidase (NAGase): The milk enzyme NAGase has an antibacterial activity and so strengthens the antibacterial-antiviral activity of the milk. It is noteworthy that the NAGase activity is similar to that in women's milk, confirming the nutritional advantages of camel milk over cow milk (Hoelzer et al., 1998).

2.3.4. Camel milk against gastrointestinal disorders

Camel milk contains a high concentration of anti-inflammatory proteins, which have a positive health effect on the stomach and intestinal disorders. The high proportion of mono and poly unsaturated fatty acids and vitamin-rich composition provide improved carbohydrate metabolism (Karray *et al.*, 2005; Konuspayeva *et al.*, 2008). Moreover, it was found that fermented camel milk has an enzyme (Angiotensin I-converting enzyme, ACE) (Quan *et al.*, 2008), which facilitates the digestion of the milk proteins (Alhaj *et al.*, 2006). Recent reports on the application of camel milk for the health of the digestive system showed that camel milk has anti-diarrhea- properties and all children, who have taken camel milk and with the 20 bouts of diarrhea per day are cured with normal bowel movements (Yagil, 2013). Camel milk can also be used in small children who have diarrhea by food contamination with rotavirus, because camel milk is rich in anti-rotavirus antibodies (Yagil, 2013).

2.3.5. Treatment of crohn's disease.

Crohn's disease is becoming an epidemic in many countries. Lately increasing evidence points to a primary bacterial infection by Mycobacterium avium -subspecies: paratuberculosis (MAP). This mycobacterium could spread via cow milk as it is unaffected by pasteurization. Apparently MAP enters the mucosa as saprophytes and only become active when the person is in severe stress, leading to a secondary autoimmune response. As the bacteria belong to the family of tuberculosis and as camel milk has been used to treat tuberculosis, it becomes apparent that the powerful bactericide properties of camel milk combined with PGRP have a quick and positive effect on the healing process. In addition, immunoglobulins attack the anti-DNA and restore the immune system (Urazakov and Bainazarov, 1991).

2.3.6. Camel milk to reduce high cholesterol in the blood

Elevated levels of cholesterol in the blood are regarded as a major risk factor for heart disease. It has been demonstrated that, administration of fermented camel milk has a hypocholesterolemic effect in rats (Elayan *et al.*, 2008). Hypocholesterol mechanism of camel milk is still unclear, but different hypotheses Volume 3, Issue XII, December 2020 | 356

were discussed, including: the interaction between bioactive peptides from camel milk and cholesterol levels is derived, which lead to cholesterol-lowering (Li and Papadopoulos, 1998) and the presence of orotic acid in camel milk (arises as an intermediate in the metabolism of the nucleic acids), which is considered responsible for the lowering of cholesterol levels in rats (Rao *et al.*, 1981) and in humans (Buonopane *et al.*, 1992).

2.3.7. Camel milk against cancer

Various scientific studies showed that application of camel milk-camel urine (drinking cure) lead to a reduction in the growth of cancer cells (Magjeed, 2005). So, a group of scientists have developed a formula of the drug for the treatment of cancer. Single doses have already been successfully tested in mice and now want to try to take place in human. The results showed that a high success rate in treating of blood cancer (leukemia). The drug may also be used successfully to treat lung, liver and breast cancer. A study from Korashy *et al.*, (2012) investigated that camel milk (but not bovine milk), significantly inhibited HepG2 (human hepatoma) and MCF7 (human breast) cells proliferation and the induction of death receptors in both cell lines and oxidative stress mediated mechanisms. The scientists believe that camel milk inhibited HepG2 and MCF7 cells survival and proliferation through the activation of both the extrinsic and intrinsic apoptotic pathways.

In addition, the potential of camel milk lactoferrin for its ability to inhibit the proliferation of colon cancer cell line, HCT-116 in vitro and the DNA damage and its antioxidant activity was evaluated for the first time (Habib *et al.*, 2013).

2.3.8. Camel milk for tuberculosis patients

A scientific study from India has led to the conclusion that there is a significant improvement of symptoms observed values through consumption of camel milk by multidrug-resistant tuberculosis ill patients. So it happened that in the test group with camel milk, administered as a dietary supplement with 1 liter/day and patient. There was no cough, sputum, chest pain more. Consequently, an increased appetite and a gain in body weight were recorded in the group, which receiving camel milk as a complement (Mal *et al.*, 2006). The exact course of the improved condition of patients consuming additional camel milk has not been investigated yet (Wernery and Yagil, 2012).

2.3.9. Therapeutic effect of camel milk for Autism

As a malfunction of the immune system causes an alimentary enzyme inhibition causing the breakdown of casein, not to amino acids, but to casomorphine. The casomorphine is a powerful, much more potent than morphine itself. Autistic children drinking camel milk have had amazing improvements in their behavior and diets. Extensive studies have demonstrated that oxidative Stress plays a vital role in the pathology of several neurological diseases, including autism spectrum Disorder (ASD); those studies proposed that GSH and antioxidant enzymes have a pathophysiological role in autism. Furthermore, camel milk has emerged to have potential therapeutic effects in autism. The previous study evaluated the effect of camel milk consumption on oxidative stress biomarkers in autistic children, by measuring the plasma levels of glutathione, superoxide dismutase, and myelo peroxidase before and 2 weeks after camel milk consumption, using the ELISA technique.

All measured parameters exhibited significant increase after camel milk consumption. These findings suggest that camel milk could play an important role in decreasing oxidative stress by alteration of antioxidant enzymes and non enzymatic antioxidant molecules levels, as well as the improvement of autistic behavior as demonstrated by the improved Childhood Autism Rating Scale (CARS) (Laila and

Nadra, 2013).

2.3.10. Treatment for allergies

The fact that camel milk lacks β -lactoglobulinand a "new" β -casein (Makinen-kijunen and Palosne, 1992), two powerful allergens in cow milk, makes the milk attractive for children suffering from milk allergies. Phylogenetic differences could be responsible for the failed recognition of camels' proteins by circulating IgEs and monoclonal antibodies. Children with severe food allergies improved rapidly with camel milk. It appears that camel milk has a positive effect in children with severe food allergies. The reactions are rapid and long lasting. Much research still needs to be done on the healing effects of the milk (Restani *et al.*, 1999).

2.3.11. Camel milk against hepatitis C and B

Hepatitis C virus (HCV) is spread worldwide and so far no effective treatment is available. To combat the disease, often use the Egyptian patients' traditional medicines, such as recording of camel milk, which contains lactoferrin Protein. Redwan and Tabll (2007) showed that incubation of human leukocytes with Camel lactoferrin then infected with HCV did not prevent the HCV entry into the cells, while the direct interaction between the HCV and Camel lactoferrin leads to a complete virus entry inhibition after seven days incubation. Today it represents the camel milk, which has the lactoferrin in slightly higher concentrations (Konuspayeva *et al.*, 2006), as a primary biotechnology drug against HCV infection (Redwan and Tabll, 2007). It have also been documented that not only lactoferrin in the camel milk is responsible for HCV infection, but also camel IgG showed ability to recognize Hepatitis C virus peptides with a significant titer in comparison with human IgG which failed to do it (El-Fakharany *et al.*, 2012). In addition, the influence of camel's milk on the immune response in chronic hepatitis B patient has been studied and demonstrated that camel milk can enhance the cellular immune response in the patient and inhibits the replication of virus DNA and promotes recovery of chronic hepatitis B patients (Saltanat *et al.*, 2009).

2.4. The Public Health Importance of Camel Milk

Nowadays, public health concern associated with microbial food safety has arisen. Numerous epidemiological reports have implicated non-heat treated milk and raw-milk products as the major factors responsible for illnesses caused by food-borne pathogens (De Buyser *et al.*, 2001; Harrington *et al.*, 2002). Cross-contamination with pathogenic microorganisms can gain access to milk either by fecal contamination or by direct excretion from the udder into milk.

In fact, most of camel milk is consumed in the raw state without any heat treatments or acid fermentation and kept at high ambient temperature coupled with lack of refrigeration facilities during milking and transporting. These conditions turn the milk to be unsafe, capable of causing food-borne diseases and it even spoil fast (Personal Communication).

Staphylococcus food poisoning is often associated with the ingestion of manually handled foods that contain one or more highly heat stable staphylococcal enterotoxins (Vanegas *et al.*, 2009; Smith, 2007). *Staphylococcus aureus* species are prevalent food borne bacterial pathogens that cause food poisoning in humans when ingested with contaminated foods (Salandra, 2008).

The safety of milk with respect to food borne diseases is of great concern around the world. This is especially true in developing countries like Ethiopia where production of milk often takes place under unsanitary conditions and the consumption of raw milk is a common practice (Wubete, 2004). In the last

few decades, SFP has been reported as third cause of food-borne illnesses in the world. Among the foods implicated in SFP, milk, dairy products and meats, particularly handled foods, play a vital role since enterotoxigenic strains of *S. aureus* have been commonly isolated in them (Ateba *et al.*, 2010). It has always been considered as one of the main causes of food poisoning (Gran *et al.*, 2002).

Nonetheless, camel milk is produced in a traditional way, and is usually collected, handled and transported in poor sanitary conditions. Moreover, camel herds rarely benefit from veterinary care and, hence, mastitis diseases are common among lactating females. Therefore, the milk produced is likely to cause food borne diseases and the natural antimicrobial factors can only provide a limited protection against specific pathogens and for a short period. Such risk is higher when the milk is consumed in its raw state as is commonly practiced by the local producers (Benkerroum *et al.*, 2003).

In research conducted in Ethiopia along the camel milk chain indicated that the mean *S. aurues* count of the three sampling points were found to be 4.2×10^4 CFU/ml and the mean count of the samples at household was 8.9×10^2 CFU/ml, 9.9×10^3 CFU/ml at primary collection centers and 1.1×10^5 CFU/ml at selling sites. The analyzed samples were generally contaminated and the microbial counts markedly variable among samples at different sampling points. In addition, the incremental change along the chain was also observed. The authors theorized that the difference in count depends on several parameters such as the milk itself, contamination of the camel's udder, hygienic handling of milking/sellers personnel and other considerations such as transportation and containers (Serda *et al.*, 2018). Thus consumption of raw camel milk should be of major concern from public health point of view. Higher levels of *S. aureus* count were detected in raw camel milk and this suggests the potential hazard associated with consumption of raw camel milk (Benkerroum *et al.*, 2003).

3. CONCLUSION AND RECOMMENDATION

Camel is a vital animal to daily life of desert dwellers as a source of food and a means of transportation, and just as importantly, its milk which has good nutritional value uses as medicines for diverse ailments. Camels produce more milk and for longer period of time than any other milk animal held under the same harsh condition. Camel milk so called white gold of the desert is more similar to human milk than any other milk. Inspite of its attribute in nutritional and medicinal value, the potential public health importance of consuming raw camel milk should be considered. Although camel milk has such values, it's less appreciated thus its consumption is restricted to pastoral area.

Based on the above outline the following recommendations are forwarded:

- > Further studies should be conducted on the chemical composition and medicinal value of camel milk.
- ➤ Camel milk should be given to the people with lactose intolerance and to diabetic patients as adjunctive with insulin therapy.
- ➤ Camel should incorporated in to diary sector
- > Training on camel in general and the chemical composition and medicinal value of camel milk in particular should be integrated in the livestock extension program
- Ethiopia which has the highest potential of camel population should give priority to further investigate the medicinal value of the animal.
- Ethiopia which has high potential of camel milk should have policy and strategies on camel milk production
- ➤ Good hygienic practice should be adopted along the milk value chain

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